

## Conference Paper

# Alien Species in the Flora of the Middle Volga Region

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## Abstract

The article presents information on the diversity and structure of the alien flora of the Middle Volga region on the border between the steppe and forest-steppe zones of the European botanical and geographical province. In the studied area, we identified 440 alien species of plants (24.6% of the total floristic diversity), including 59 invasive and potentially invasive species, the dispersal of which has already caused environmental consequences or could become a threat in the future. According to the degree of naturalization, alien plant species among the regional flora are represented by 146 ephemerophytes (33.2%), 122 colonophytes (27.7%), 151 epiphytes (34.3%) and 21 agriophytes (4.8%). As verified via the main method of skidding, alien species are distributed almost equally – 228 xenophytes (51.8%) and 212 ergasiophygophytes (48.2%). It was revealed that of the 150 species of alien plants, there are only 84 of the most common European species in the Middle Volga region, most of which do not show high cenotic activity. The obtained results actualize the development of a system of ecological and economic assessment of the consequences of introducing alien plant species into regional flora.

**Keywords:** alien plants, invasive species, Middle Volga region, regional flora

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Received: 12 September 2018

Accepted: 15 October 2018

Published: 29 October 2018

Publishing services provided by  
Knowledge E

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Selection and Peer-review under the responsibility of the Ecology and Geography of Plants and Plant Communities Conference Committee.

## 1. Introduction

Invasive species are large-scale phenomena that pose a threat to biological diversity: they are one of the most serious environmental problems facing humanity [1–4]. However, not every Russian region has a list of invasive plant species. The lack of available data for Russia was also noted by the authors of a recent review of the world's invasive flora [3].

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At present, we have prepared a summary of the invasive flora of the Middle Volga region; the results of our analysis are presented in this article.

## 2. Methods

The Middle Volga region is traditionally considered to be within the boundaries of Samara and Ulyanovsk regions, covering an area of 90.9 thousand km<sup>2</sup>. The floristic diversity of the region is at least 1,990 species, belonging to 695 genera and 138 families. The alien fraction of the flora consists of 490 species, 24.6% of the total flora. Of these, 440 species belonging to 260 genera and 70 families (90% of the total species diversity) are included in the analysis. The flora of the region is analyzed on this scale here for the first time. The analysis does not include species found more than a few decades ago, findings unconfirmed by a herbarium and plants indigenous to one part of the studied region that occur in the disturbed habitats of another part of the region and manifest themselves as invasive. Also, species with a dubious status are not included, since their adventitious nature in the region requires confirmation.

The basis of the research is the published reports on the flora of Samara and Ulyanovsk regions [5, 6]: we also take into account new data on the distribution of invasive plants obtained as a result of field research, work with herbaria and the literature.

When classifying species of invasive flora by the degree of naturalization, we used the most common terminology system [7, 8]. In determining life strategies, we used the dichotomous key cited in the work of J. Grime et al. [9].

The nomenclature of taxa is given, basically, in accordance with the International Plant Names Index [10].

## 3. Results

The family-species spectrum of alien flora of the Middle Volga region is not unique and corresponds to the one compiled for the European part of Russia [11]. The spectrum consists of the following families: *Asteraceae* (59 species), *Poaceae* (54), *Brassicaceae* (36), *Rosaceae* (34), *Fabaceae* (27), *Chenopodiaceae* (19), *Lamiaceae* (14), *Apiaceae*, *Caryophyllaceae* and *Solanaceae* (11 species each). Nine leading families are also characteristic for the European spectrum [1]. The exception is *Solanaceae* – on the European continent, it gives way to *Plantaginaceae* and *Onagraceae*. In all, the top ten families

account for 276 species (62.7%). Other 21 families contain 3 to 10 species (114 species, 25.9%), while another 39 families contain from 1 or 2 species (50 species, 11.4%).

Of the leading genera in the European flora [1] among the alien plants in the first 9 genera of the spectrum of regional flora, there are only *Euphorbia* and *Chenopodium*. The genera with largest number of species are *Vicia* (8 species), *Amaranthus* and *Chenopodium* (7 species), *Euphorbia*, *Rosa* and *Setaria* (6 species) and *Allium*, *Lepidium* and *Veronica* (5 species). *Chenopodium*, *Euphorbia*, *Veronica*, *Amaranthus*, *Lepidium*, *Vicia* and *Rosa* are some of the most common species of alien flora in the European part of Russia [11]. 12 genera contain 4 species, 27 genera – 3, 44 genera – 2 and 168 genera are represented by a single species.

The analysis of life forms shows a sharp prevalence of annuals – 235 species (53.4%), while biennials are represented by 31 species (7.0%), herbaceous perennials – 97 species (22.1%), shrubs – 54 species (12.3%) and trees – 23 species (5.2%). The significant proportion of annuals and the predominance of herbaceous plants over the wood ones in the alien group are characteristic for most regions of the European part of Russia.

When analyzing the geographic composition of the invasive flora of the Middle Volga region, the plant areas are grouped into 8 florogenetic groups. The predominance of the European-Asian species (136 species, 31.0%, including 40 species of the European-South-West Asian range) and the Asian (114 species, 26.0%, including 40 species of the East Asian range) florogenetic groups was revealed. An essential role is played by the plants of the American florogenetic group – 89 species (20.2%), among which are 69 North American species. The European group is represented by 68 species (15.5%). There are significantly fewer African plants (4, 0.9%) and species originating in culture (18, 4.0%), as well as Holarctic (5, 1.1%) and Eurasian (6, 1.3%) types of areals.

According to the main methods of dispersal, alien species are distributed almost equally – 228 xenophytes, that is, accidentally introduced species (51.8%), and 212 ergasiophygophytes, that is, ‘fugitives from culture’ (48.2%). Thus, invasive plants with the same frequency ‘leave’ from culture and are introduced spontaneously.

The structure of the alien flora of the Middle Volga region according to the degree of naturalization is as follows: 146 ephemerophytes (33.2%), 122 colonophytes (27.7%), 151 epekophytes (34.3%) and 21 agriophytes (4.8%). The naturalization of species is directly related to their inherent life strategies, the identification of which is of great importance for understanding the biology and ecology of alien species, as well as for assessing the prospects for their consolidation in a new territory.

The main types of life strategies (R, S and C) account for 32.1%, of which the pre-dominant share is taken by ruderal species found in habitats with a significant level of disturbance. These are mainly annuals and short-lived weeds: the genera *Amaranthus*, *Ambrosia*, *Atriplex*, *Chenopodium*, *Lepidium*, *Cardaria draba*, *Conyza canadensis*, *Cyclachaena xanthiifolia*, *Dodartia orientalis*, *Kochia densiflora*, etc. Stress-tolerant plants are adapted to the effects of unfavorable factors and the temporary availability of resources characteristic of poor habitats. The herbaceous plants include species of the following genera: *Corispermum*, *Leymus*, *Juncus tenuis*, *J. dichotomus*. The species from the woody plants include *Hippophaë rhamnoides* and *Mahonia aquifolium*, etc. There are not many direct competitors: *Elodea canadensis*, *Lupinus polyphyllus* and *Phragmites altissimus*. A small group of species possesses the features of all three types of strategies, including *Ballota nigra*, *Onobrychis viciifolia*, *Acorus calamus*, and species of genera *Solidago*, *Symphyotrichum*, etc.

The most numerous group were species of stress-tolerant-ruderal plants. Most of them are bereaved annuals and short-lived, such as species of the genera *Allium* and *Helianthus*, *Hemerocallis fulva*, *Phalacrocoma septentrionalis*, *Nepeta cataria*, etc., as well as weedy species from the genera *Centaurea*, *Lamium*, *Senecio*, *Astrodaucus littoralis*, *Chaerophyllum aureum*, *Lamium purpureum* and *Urtica urens*. Some arboreal plants, such as species of the genus *Rosa*, *Chaenomeles japonica*, *Sorbaria sorbifolia*, also belong here.

Among the ruderal competitors are rather large fast growing short-lived plants (*Conium maculatum*, *Heracleum sosnovskyi*, *Impatiens glandulifera*, *Onopordum acanthium*, *Hyoscyamus niger*, species of the genus *Oenothera*, etc.), rhizome (species of the genus *Symphytum*, *Xanthoxalis stricta*), or root-crop (*Acroptilon repens*, *Ambrosia psilostachya*) plants.

The stress-tolerant competitors include species living in habitats with a low level of disturbances or those that are firmly embedded in natural communities – *Acer negundo*, *Echinocystis lobata*, *Parthenocissus inserta*, *Ulmus pumila*, species of the genera *Epilobium*, *Sambucus*, and others. 37 species have an indefinite type of life strategy, mainly tree- and shrub-ergasiophygophytes.

Among the alien species, we identified coenotically active (50 species), low-active (46) and inactive (344) ones. The largest number of active species is represented by annuals (27 species) and perennials (14). Among them are widely distributed species, the active settlement of which began in the second half of the 20<sup>th</sup> century and continues at the present time. Moreover, active and low-active species predominate among xenophytes (41), whereas among the ergasiophygophytes they are far fewer

(24 species). This is a group of highly active plants that requires close attention, as they have the greatest chance of achieving naturalization in the region and expanding further.

Among the species of this group are plants actively naturalized in natural and semi-natural habitats (*Atriplex tatarica*, *Conyza canadensis*, *Impatiens parviflora*, *Lepidium densiflorum*, etc.), naturalized and actively dispersed in anthropogenic habitats (*Acroptilon repens*, *Amaranthus retroflexus*, *Ambrosia trifida*, *Cardaria draba*, *Cuscuta campestris*, *Cyclachaena xanthiifolia*, *Galinsoga ciliata*, *Hordeum jubatum*, *Lepidotheca suaveolens*, etc.), potentially invasive species (*Ambrosia artemisiifolia*, *Arrhenatherum elatius*, *Lupinus polyphyllus*, *Sisymbrium volgense*, *Thladiantha dubia*, etc.) and transformers species (*Bidens frondosa*, *Echinocystis lobata*, *Elaeagnus angustifolia*, *Elodea canadensis*, *Heraclium sosnowskyi*, *Impatiens glandulifera*, *Parthenocissus inserta*, *Phragmites altissimus*) [12].

Analysis of 616 floristic descriptions made it possible to identify the most common alien plant species in the region: *Conyza canadensis*, *Tripleurospermum inodorum*, *Acer negundo*, *Lactuca serriola*, *Sisymbrium loeselii*, *Ulmus pumila*, *Dracocephalum thymiflorum*, *Cyclachaena xanthiifolia*, *Saponaria officinalis* and *Consolida regalis*. According to P. Pyšek et al. [3], *Conyza canadensis* tops the list of the most common invasive species in temperate latitudes.

Out of the 150 species of alien plants most common in Europe [3], in the Middle Volga region there are only 84 species, and most of them do not show high activity.

Since the beginning of the 21<sup>st</sup> century, 126 alien species new to the region have been found. Among the latest findings are *Echinochloa esculenta*, *Eriochloa villosa*, *Juncus dichotomus*, *Isatis praecox*, *Petrorhagia saxifraga*, *Malus niedzwetzkyana*, *Potentilla × tobolensis*, *Rosa tschatyrdagi*, *Elaeagnus oxycarpa* and *Chaerophyllum aureum*.

## 4. Conclusion

Thus, the analysis of modern data on the structure and taxonomic diversity of invasive species in the flora of the Middle Volga makes it possible to draw the following general conclusions. Currently, there is a high rate of adventitization in the regional flora – 126 alien plant species (28.6% of the total number) recorded over the past 17 years. Until now, there has been no assessment of the impact of invasive plants on the vegetation cover of the region. The family-species spectrum of the invasive flora of the Middle Volga region is similar to that of the European part of Russia and of Europe as a whole. The regional specificity is mostly reflected in the generic spectrum and at the species

level – only *Euphorbia* and *Chenopodium* are among the top ten European flora of invasive plants; but among the 150 species of invasive plants most common in Europe [1], in the Middle Volga region there are only 84 species, and most of them do not show high activity in the researched region. Based on data on coenotic activity, life strategies and the spread of alien species, 59 invasive and potentially invasive species have been identified in the region, the distribution of which has already caused environmental effects or may become a threat in the future [12]. The prepared outline of the alien flora of the Middle Volga region could be a basis for monitoring these dynamics and their intensity, and also actualizes the development of a system of environmental and economic assessment of the consequences of the introduction of invasive plant species into the regional flora.

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